

SUPPORT FOR THE AMENDMENT

Support for the amendments to claims 1 and 7 is found on page 10, lines 23-24 of the specification and in claim 5 as originally presented. Support for the amendment to claim 8 is found on page 22, line 25 through page 23, line 4 of the specification. No new matter would be added to this application by entry of this amendment.

Upon entry of this amendment, claims 1, 4, 6-8 and 10-16 will now be active in this application.

### REQUEST FOR RECONSIDERATION

The claimed invention is directed to a hologram recording material and a process for producing same.

Hologram recording materials are typically valued based on properties of a high refractive index change at the time of recording, a high sensitivity, low scattering, environmental resistance, durability, low dimensional changes and high multiplicity. Issues as to environmental resistance and durability has focused on inorganic matrix materials as well as hybrid materials. Issues with inorganic hybrid matrix materials have focused on the uniformity of film formation, compatibility with the optically active monomer, curing speed and refractive index. Research continues into hologram recording materials having good properties.

The claimed invention addresses this problem by providing a hologram recording material comprising a metal oxide matrix and a photopolymerizable compound having an aromatic ring, wherein the metal oxide matrix has a halogenated C<sub>1-4</sub> alkyl group and an organic group containing no halogen. Applicants have discovered that the presence of a halogenated C<sub>1-4</sub> alkyl group in the metal oxide matrix which also contains an organic group containing no halogen provides a material having a high refractive index, high sensitivity, low scattering, environmental resistance, durability, low dimensional change, high multiplicity and compatibility with a polymerizable monomer. Such a hologram recording material is nowhere disclosed or suggested in the cited references of record.

The rejections of claims 1, 3-8, 10, 12-14 and 16 under 35 U.S.C. §103(a) over Chandross et al. EP 938,027 in view of Loy et al. *Chem Mater*, Shustack et al. U.S. '566 and Hiruma et al. U.S. '831, of claims 1, 3-8, 10 and 12-16 under 35 U.S.C. §103(a) in further view of Otaki et al. and of claims 1, 3-8, 10-16 under 35 U.S.C. §103(a) in further view of Poutasse et al. '782 or Zeldin et al. U.S. '172 are respectfully traversed.

None of the cited references of record disclose or suggest the claimed hologram recording material having a halogenated C<sub>1-4</sub> alkyl group nor the improved compatibility between the matrix and the photopolymerizable monomer resulting there from.

Chandross et al. EP '027 has been cited for a disclosure of a holographic recording medium based on methyltriethoxysilane, phenyltriethoxysilane, lauryl acrylate and a photoinitiator which is hydrolyzed to form a holographic recording material (examples 1-3). EP '027 corresponds with the disclosure in JP A-11-344917 discussed on page 3, lines 1-18 of applicants' specification and is reproduced below:

[0005] JP-A-11-344917 discloses an optical recording medium wherein an organic-inorganic hybrid matrix contains an optically active monomer. In the organic-inorganic hybrid matrix, a metal element has an alkyl group (a methyl group) or an aryl group (a phenyl group). However, the introduction of the methyl group makes it impossible to improve the compatibility between the hybrid matrix and the optically active monomer. The introduction of the phenyl group gives a more improvement in the compatibility than the introduction of the methyl group. However, the introduction of the phenyl group causes a fall in the curing speed

of a hybrid matrix precursor ([0015] in the above publication), and causes a rise in the refractive index of the hybrid matrix. If the refractive index of the hybrid matrix becomes high to approach the refractive index of the optically active monomer or a polymer therefrom, a high refractive index change is not easily obtained at the time of recording. This fact makes the flexibility in recording medium design narrow.

Above [0015] corresponds to [0016] of EP 938 027.

While the reference discloses an alkyl (a methyl group) or aryl group (a phenyl group) and that **the organic components** provide compatibility with the organic components (the photoactive monomer) of the photoimageable system, there is no disclosure of a halogenated C<sub>1-4</sub> alkyl group.

Loy et al. has been cited for a disclosure of sol-gels with halogen containing organic groups and that chloromethyl and chloromethylphenyl groups **react more slowly** than methyl, the **pore diameter** of chloromethyl is slightly **larger** than for that of methyl and that hydrogen, methyl and chloromethyl are **more transparent** than ethyl, dodecyl, hexadecyl, octadecyl and vinyl (page 3629, Table 6).

The official action asserts that it would have been obvious to one of ordinary skill in the art, based on the disclosed transparency in Loy et al. to have replaced the methytriethoxysilane of EP '027 with a chloromethyltriethoxysilane as disclosed in Loy et al. however, the measured transparency is for **that of the gel** itself, and not for a photorecording medium containing a photoactive organic monomer.

However, the claimed hologram recording material comprises a metal oxide matrix and a photopolymerizable monomer. As a technical point, it is important that a hologram recording material is obtained in a transparent state **at the coexistence of both of the components of the matrix and the monomer**. Even for a transparent matrix, **poor compatibility** between the **transparent matrix** and the photopolymerizable monomer or the polymer product makes it **impossible** to obtain **a transparent hologram recording material**, or to maintain the transparency of the resultant material at the time of recording.

According to the claimed invention, introduction of a halogenated C<sub>1-4</sub> alkyl group into a transparent metal oxide matrix makes it possible to obtain a hologram recording material having a remarkably improved compatibility between the matrix and the photopolymerizable compound having an aromatic ring and a remarkably improved compatibility between the matrix and an organic polymer generated at the time of recording (see page 5, lines 3-9 of applicants' specification). Namely the resultant hologram recording material having an improved compatibility is transparent, and the transparency of the material is maintained at the time of recording. There is no suggestion that a halogenated C<sub>1-4</sub> alkyl

group would be more transparent than non-halogenated group or any suggestion of an enhanced compatibility between the gel and the photopolymerizable monomer or a polymer generated by polymerization of the monomer.

As evidence of the relationship between matrix transparency and transparency of a hologram recording material, the examiner's attention is directed to Example 1 and comparative examples 1 and 2 on pages 24-30 of applicants' specification.

Comparative example 1 prepared from tetraethoxysilane and **methyltriethoxysilane** yielded a **transparent matrix** by the sol-gel process. When this transparent matrix was mixed with a photopolymerizable compound of 2,2-bis[4-(acryloxy-diethoxy)phenyl]propane, the two compounds were not dissolved in each other such that the composition became **clouded** and a transparent hologram recording material was **not obtained**.

Likewise, comparative example 2 prepared from tetraethoxysilane and **phenyltriethoxysilane** yielded a **transparent matrix** by a sol-gel process. However, while mixing of the transparent matrix with a photopolymerizable compound of 2,2-bis[4-(acryloxy-diethoxy)phenyl]propane, yielded a transparent hologram recording material, white **cloudiness** was generated **at the time of recording**. Thus the transparency of the material was not maintained, because the compatibility between the matrix and the polymer generated at the time of recording was insufficient.

In contrast, example 1 prepared from tetraethoxysilane and **chloropropyltriethoxysilane** provided a **transparent matrix** which when mixed with a photopolymerizable compound of 2,2-bis[4-(acryloxy-diethoxy)phenyl]propane, provided a transparent hologram recording material, the **transparency of which was maintained** after recording.

Accordingly, the mere disclosure of transparency of the gel itself fails to provide motivation to replace methyltriethoxysilane with chloromethyltriethoxysilane nor provide any expectation of enhanced compatibility between the matrix and a photopolymerizable monomer or a polymer generated by the photopolymerizable monomer. Applicants note that the claims have been amended to recited the use of a halogenated C<sub>1-4</sub> alkyl group and a photopolymerizable compound having an aromatic ring, to better reflect the evidence of record.

While page 6 of the outstanding official action speculates the role of refractive index may have on the performance, applicants note that example 1 uses the same phenoxyethyl acrylate as used in comparative example 2 but whit cloudiness was not generated upon hologram recording as a result of introduction of a halogenated C<sub>1-4</sub> alkyl group. It appears that the poor compatibility between the matrix and the organic polymer generated at the time of recording in comparative example 2, is more of an issue in causing the cloudiness than the refractive index of the monomer used.

Enhanced compatibility is not suggested by either of the references of Shustack et al. or Hiruma et al.

Shustack et al. has been cited for a disclosure that (bromophenyl)trimethoxysilane and (chlorophenyl)trimethoxysilane **lowers scattering losses** in the field of fiber optic communications. The reference discloses at paragraph [0025] that a coupling agent having a high refractive index provides a material with a smooth refractive index gradient between the condensed metal oxide nanoparticles and the somewhat lower refractive index organic portion of the materials, and therefore **lowers scattering loss**. The reference further identifies functionalities of chlorine, bromine, iodine, sulfur, selenium, phosphorus, an aromatic ring or a highly conjugated unsaturated system as providing a high refractive index (pg 3, left column, lines 15-21). Thus, the effect of halogen substitution is expected to lower

scatter loss. There is no suggestion of improved compatibility with a photopolymerizable monomer.

Hiruma et al. describes inclusion of a silane coupling agent to a primer layer to improve the bonding power to the support and imparting water resistance to the primer layer. There is no disclosure of improving compatibility with a photopolymerizable monomer.

There simply is no suggestion in the cited secondary references of enhanced compatibility by introduction of a halogen into the matrix material.

As the cited combination of references neither discloses or suggest the claimed combination nor the improvements in a holographic recording material resulting there from, the claimed invention is not rendered obvious from the cited references and withdrawal of the rejection under 35 U.S.C. §103(a) is respectfully requested.

The objection to claim 8 has been obviated by amendment to recite the presence of a substrate. No cancelation of this claim is believed to be necessary.

The rejection of claim 16 under 35 U.S.C. §112, second paragraph has been obviated by amendment such that the metes and bounds of claim 16 would be clear to those of ordinary skill in the art. Withdrawal of this ground of rejection is respectfully requested.

Applicants submit that this application is now in condition for allowance and early notification of such action is earnestly solicited.

Respectfully submitted,

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